AGS as a LARP test bench for PS2

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Introduction

LARP stays for LHC Accelerator Research Program. R&D on the LHC injector chain upgrade programs were recently included in the task list. In the last LARP collaboration meeting has been decided to support (at a certain level) an R&D program on:
Fast transverse profile diagnostic and phase space reconstruction techniques.
At present the project is not finalized yet, we are working to prepare a collaboration involving BNL, FNAL and CERN to propose it as a LARP task in the next collaboration meeting.
Some preliminary work is needed to present a sound proposal possibly taking advantage of beam time at the AGS.

" ... phase-space diagnostics proposal is an interesting project that could become extremely useful. [In FY10 we] would try to support the modest request for Phase-space (MTE) diagnostics ", U. Wienands

"[For PS2 LARP task] Use this year to choose one or two key topics. Multi-lab interest important criterion.", E. Prebys

AGS and PS2

AGS and PS2 will be similar machines:

- Injection energy: 1.5GGeV , 4GeV
- Extraction energy: 28GeV , 50GeV
- Circumference: 860m, 1344m
- Cycle time: 4s, 2.4s
- Bunch intensity: 1.5e11 - 2.5e11, 4.2e11 - 7e11 ppb
- Harmonic number: 12, 180
- Bunch spacing: 225ns (minimum) otherwise 860m/c, 25ns

More parameters in `http:`

`//care-hhh.web.cern.ch/CARE-HHH/LUMI-06/psplusetcparameters.htm`

Phase-space diagnostics for PS2

LHC operation relies on the emittance preservation in the LHC injection chain. There are LHC upgrade scenarios with lower than nominal emittance.

In PS2 multiturn island extraction (MTE) is a challenging extraction technique that relies on complex phase space manipulation. PS2 complex phase space manipulations would profit from fast beam profile monitor able to deliver turn by turn data.

Measuring the emittance evolution is, for every machine, a source of invaluable information for understanding of the behaviour of the beam and maximize the performance.

Ionization Profile Monitor

BNL has expertise in fast non destructive profile monitor that can be used as a routine tool for diagnostic and machine optimization purposes.

Possible synergies with FNAL and CERN IPM experience.

A prototype IPM from RHIC might be installed in the AGS during this run and therefore compare two families.

Luminescence profile monitor is an interesting alternative option, but its time scale is longer.

Studies in AGS for the FY09 run

Test IPM response and compare with independent measurements.

Use IPM data to test phase space reconstruction algorithms. Simulations studies using ART algorithm showed promising results even in presence of dispersion.

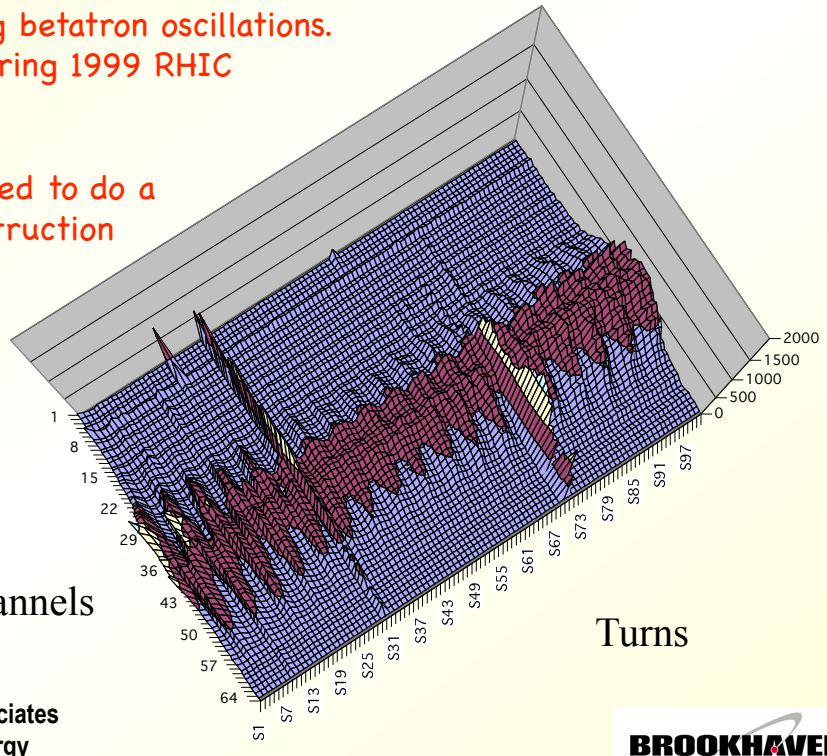
Study the feasibility of build island in the phase space. Trim quads are able to change the tune to resonant working point (.25 or .75 to match CERN experience, but other possibilities are possible). Sextupoles used for slow resonant extraction can drive resonances at various energy. Octupoles may be used at low energy.

IPM

RHIC IPM record of first 100 turns of one bunch at injection showing betatron oscillations. Data were taken during 1999 RHIC commissioning.

These data were used to do a tomographic reconstruction of phase space.

R. Connolly, *et.al.*
Nucl. Instr. and Meth. A
443 (2000) 215-222.



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R&D is needed to increase the cross section, improve the electron sensitivity for the front end, reduce the space charge effects.

Tomography

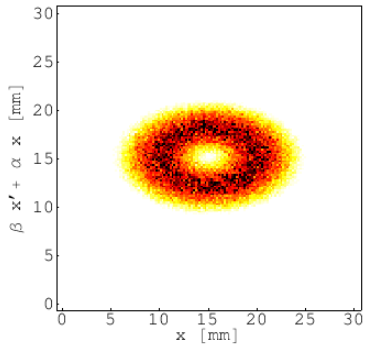

Figure 1: The test distribution in transverse phase space.

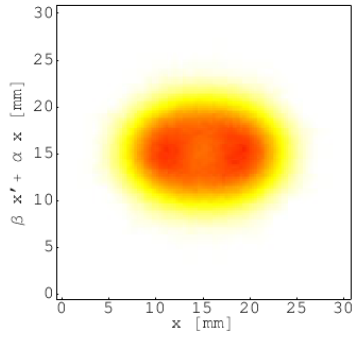

Figure 2: Reconstruction with ART, using no dispersion correction.

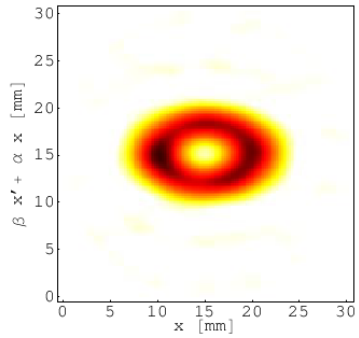

Figure 3: Reconstruction with ART, using dispersion correction.

Simulation from Tomographic reconstruction of transverse phase space from turn-by-turn profile data, S. Hancock, A. Jansson, M. Lindroos, Particle Accelerator Conference, New York, USA, 29 Mar - 2 Apr 1999. Publ. in: Proceedings, (CERN-PS-99-029-OP).

Multi turn extraction (MTE)

(Loading ct3t.avi)

Simulation from

`http://cern.ch/AB-Project-MTE/Documentation/Movies/ct3t.gif`

Studies in AGS for the FY10 run

Develop new IPM or improve existing one based on the experience of this run and install them in the AGS.

Improve the ability to create island in the phase space. They can be used to verify model and instrumentation.

Optimized the reconstruction algorithms.

People interested and potential contributors

Several additional people showed interest in this program and may potentially join:
C. Montag (BNL) (tomography)
S. Peggs (BNL) (tomography)
A. Jansson (FNAL) (IPM, tomography)
B. Dehning (CERN) (IPM)
M. Giovannozzi (CERN) (MTE)
S. Gilardoni (CERN) (MTE, tomography)
S. Hancock (CERN) (tomography)

Conclusion

The AGS similarities to the PS2 allow to use it as test bench for R&D related activities.

The present program on IPM may be embedded in a larger collaboration effort hosted in BNL.

Phase space manipulations require good diagnostic and good understanding machine models and those studies may eventually improve both on AGS.